

What is claimed is:

1. A catheter-flushing system for maintaining the patency of the lumen of an indwelling catheter, the catheter having a indwelling portion beneath the skin of a patient, the system comprising:
  - a patient mounted tubing system in fluid connection with said indwelling portion, said tubing system defining an internal volume and at least one proximal terminal for intermittent connection with an external fluid source, said proximal terminal including a seal for promptly sealing upon disconnection of said source, so that at least a portion of said flush solution entering said tubing system through said terminal remains sealed within said tubing system after said source has been disconnected from said system, thereby defining a residual volume of flush solution within said tubing system,
    - a volume reducer for connection with said system and for progressively reducing said internal volume at a plurality of different times, to displace a plurality of fractions of said residual volume into said indwelling portion of said catheter to intermittently flush said indwelling portion with said flush solution.
2. The catheter-flushing system of claim 1, wherein said flush solution is saline.
3. The catheter flushing system of claim 1, wherein said flush solution is a mixture of diluent and at least one of an anticoagulant and an antimicrobial agent.
4. The catheter flushing system of claim 3, further wherein said volume reducer is comprised of a plurality of clamps.
5. The catheter flushing system of claim 1, wherein said volume reducer is mounted with said tubing system.

6. The catheter flushing system of claim 1, wherein activation of said volume reducer reduces the volume within said tubing system by at least one discrete volume.
- 5        7. The catheter flushing system of claim 1, wherein a plurality of activations of said volume reducer reduces the volume within said tubing system by a plurality discrete volumes at a plurality of different times to provide intermittent flushing of said catheter portion over a prolonged time interval.
- 10      8. A patient mounted system for providing intermittent bolus injection of a flush solution through an indwelling catheter to intermittently flush the lumen of said catheter, the system comprising:  
a tube for mounting with a patient, the tube having distal end connectable to said catheter and at least one proximal end with a terminal for intermittent connection with a source of flush solution, said terminal including a seal for sealing said proximal end of said tube when said source of flush solution is disconnected from said terminal, said tube further defining an internal open space defining a variable internal volume and a lumen extending therethrough from said sealed proximal terminal to said distal end, so that when a source of flush solution is connected to said terminal, flush solution can enter said tube from said source through said terminal and flow through said lumen to at least partially fill said internal space, said lumen defining at least a portion of said internal volume,
- 15      a volume reducer comprised of at least one volume reducing element mounted with said system, said volume reducer being configured for sequentially reducing said internal volume of said tube at a plurality of different times after said distal end has been connected with said catheter, said flush solution has been flowed into said space from said source, and said source has been disconnected from said terminal.
- 20      25      9. The system of claim 8, wherein said tube is elongated.
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10. The system of claim 8, wherein said tube is flexible.
  11. The system of claim 8 wherein volume reducer is a clamp mounted  
5 with said tube.
  12. The system of claim 8, wherein said volume reducer is comprised of  
a plurality of reducing elements.
- 10 13. The system of claim 12, wherein said elements comprise clamps  
mounted with said tube.
14. The system of claim 11, wherein said clamp is a pinch clamps.
- 15 15. The system of claim 11, wherein said clamp defines at least one  
elongated opposing surfaces for compressing said tube.
16. The system of claim 11, wherein said clamp defines opposing  
elongated opposing surfaces for compressing said tube.
- 20 17. The system of claim 8, wherein said tube defines at least one internal  
diameter and wherein said diameter is variable.
18. The system of claim 8, wherein said tube defines at least one internal  
25 diameter and includes an enlarged portion having an increased internal diameter  
adjacent said at least one element.
19. A medical device for administration of fluid to a patient comprising:  
a patient mounted, fluid-lock system having distal portion for insertion  
30 into a blood vessel to define an indwelling portion, said system having an  
internal space defining an internal volume, said pressure within said space being

- essentially equal to the pressure in the blood vessel when said indwelling portion resides within said blood vessel, said system further having at least one proximal terminal for intermittent connection with an external fluid source, said proximal terminal including a seal for sealing upon disconnection of said source,
- 5 so that at least a portion of said flush solution entering said fluid-lock system through said terminal from said source remains sealed within said fluid-lock system after said source has been disconnected from said fluid-lock system, thereby defining a residual volume of flush solution within said fluid-lock system,
- 10 a volume reducer for engaging said system and for reducing the volume of flush solution contained within said space by facilitating the movement of at least a portion of said flush solution into said blood vessel.
20. The medical device of claim 19, wherein said volume reducer is
- 15 configured to progressively reduce said internal volume at a plurality of different times, to displace a plurality of fractions of said residual volume into said indwelling portion to intermittently flush said indwelling portion with said flush solution.
- 20 21. The medical device of claim 19, wherein said distal portion is a catheter.
22. The medical device of claim 19, wherein said fluid lock system includes a tube, said tube defining at least a portion of said internal space.
- 25 23. The medical device of claim 22, wherein said volume reducer is mounted with said tube.
24. The medical device of claim 22, wherein said volume reducer is
- 30 configured to reduce the volume of said tube.

25. The medical device of claim 19, wherein said volume reducer is configured to progressively reduce the volume within said tube by a plurality discrete volumes.

5        26. The medical device of claim 19, wherein said volume reducer is configured to progressively reduce the volume within said tube by a plurality substantially equal volumes.

10      27. A system for maintaining at least one of the patency and sterility of the lumen of a catheter the system within the blood vessel of a patient, said blood vessel containing flowing blood, said lumen defining a distal end within said blood vessel, the system comprising:

15      a mixture of a diluent and at least one of a anticoagulant and a antimicrobial said mixture defining a predetermined concentration of said at least one antimicrobial and anticoagulant,

20      a reservoir fluid-locked with said catheter for storing said mixture, said reservoir being in fluid communication with a blood vessel through said lumen, the reservoir defining an internal space filled with said mixture, said space having a internal pressure essentially equal to the pressure within the blood vessel, such that said mixture within said lumen interfaces with blood within the blood vessel at a mixture-to-blood interface adjacent said distal end of said lumen,

25      a volume reducer configured for engaging said reservoir and for securely reducing the volume of said mixture contained within said space to cause the movement of at least a portion of said mixture into said interface to increase said concentration of said mixture along said interface.

30      28. The system of claim 27, wherein said volume reducer includes at least one element for reducing the volume of the reservoir by predetermined discrete and limited increments at a plurality of different times to increase the

efficacy of said mixture with a minimum of transfer of said mixture into the patients blood vessel.

29. A system for maintaining at least one of the patency and sterility of  
5 the lumen of a catheter the system within the blood vessel of a patient, said  
blood vessel containing flowing blood, said lumen defining a distal end within  
said blood vessel, the system comprising:
- a flush solution,
  - a reservoir fluid-locked with said catheter for storing said flush solution,
  - 10 said reservoir being in fluid communication with a blood vessel through said  
lumen, the reservoir defining an internal space substantially filled with said flush  
solution and said space having a internal pressure essentially equal to the  
pressure within the blood vessel, such that said flush solution within said lumen  
interfaces with blood within the blood vessel at a solution-to-blood interface
  - 15 adjacent said distal end of said lumen,
    - a volume reducer for engaging said reservoir and for reducing the volume  
of said flush solution contained within said space by facilitating the movement  
of at least a portion of said flush solution into said interface to increase the  
concentration of said solution along said interface, said volume reducer
    - 20 including at least one element configured for securely reducing the volume of  
the reservoir by predetermined discrete and limited increments at a plurality of  
different times to increase the efficacy of said flush solution with a minimum of  
transfer of the flush solution into the patients blood vessel.
- 25 30. A method for intermittently flushing the lumen of an indwelling  
catheter with fluid derived from an external fluid source when said catheter is no  
longer in fluid communication with said external fluid source, the catheter  
having a indwelling portion beneath the skin of a patient and extending into a  
blood vessel, the method comprising steps of:

- disposing a patient mounted tubing system in fluid connection with said indwelling portion, said tubing system defining an internal volume and at least one proximal terminal,
- flowing flush solution from said external fluid source, through said at
- 5   least one terminal and through said tubing system into said indwelling portion, at least a portion of said solution at least partially filling said internal volume,
- promptly sealing said proximal terminal of said tubing system such that at least a portion of said flush solution remains sealed within said tubing system thereby defining a residual volume of flush solution within said tubing system,
- 10   and
- progressively reducing said internal volume of said tubing system to displace at least a portion of said residual volume into said indwelling portion to flush said indwelling catheter portion with said flush solution.